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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/991,230	11/14/2001	James R. Priest	25135A	3945

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EXAMINER	
ARTMAN, THOMAS R	

ART UNIT	PAPER NUMBER
2882	

DATE MAILED: 11/24/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/991,230	PRIEST ET AL.
	Examiner	Art Unit
	Thomas R Artman	2882

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 01 September 2004.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1,6,8 and 10-15 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1,6,8 and 10-15 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 14 November 2001 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 6 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hanzawa (US 5,231,685) in view of Wright (US 5,212,750) and Higdon, et al. (Mechanics of Materials, 4^{th} Ed., 1985).

Regarding all three claims, Hanzawa discloses a crimp-style optical fiber connector (Figs.15 and 16) and a method of connecting a crimp-style optical fiber connector, including:

1) providing a crimp ring 10 configured to couple with a base ring 9, and

2) selecting the base ring having a leading edge where at least a portion of a selected at least one reinforcement fiber 8 is secured over the leading edge of the base ring and underneath the crimp ring.

Hanzawa does not specifically disclose that the leading edge of the base ring has a radius of curvature greater than or equal to the minimum bending radius of the reinforcement fiber that prevents the fiber from tensile failure, where the critical bending radius is a function of the diameter, elastic modulus and tensile strength of the reinforcement fiber as shown by the claimed equation.

Wright teaches the importance of designing radii of curvature for leading edges of fixtures for reinforcement fibers in order to prevent failure under tension. As shown in Fig.3, reinforcement fibers 35 are bent around leading edges 67 and 71 and are crimped by ring 73 on clamping surface 72. The radii of curvature for these edges are designed to be greater than or equal to the radius at which the fiber will fail (see at least col.7, line 62, to col.8, line 7). This improves the performance, such as load bearing strength and longevity, of the reinforcement fibers.

Further regarding the above claims, Wright does not specify that the critical bending radius is a function of the elastic modulus, the diameter and the tensile strength of the reinforcement fiber as shown by the claimed equation.

Higdon shows the mathematical derivation of relating the elastic modulus E, the diameter (twice the radius c), and the tensile stress, σ, to the radius of curvature, ρ, for a rod that is bent (p.356, equations 7-1 and 7-2). Therefore, Higdon demonstrates that it is a fundamental fact known in the art that the bending radius is a function of the diameter, the elastic modulus and the tensile stress of the reinforcement fiber. One skilled in the art can readily arrive at the claimed equation from the elementary application of equations 7-1 and 7-2.

These equations by themselves do not specifically disclose that the *critical* bending radius is a function of the tensile *strength* of the material, where the tensile strength is a maximum tensile stress of the material. However, one skilled in the art would readily contend that a critical parameter of an object to be modeled that is limited by another parameter can be calculated directly. Higdon directly suggests this, for example, in problem 7-5 on p.357, where a critical dimension of the object to be modeled is limited by the maximum allowable stress of the

object to be modeled. The same mathematical relationship and thought process that is needed to solve problem 7-5 is also required for the claimed invention, where the critical dimension is limited by the maximum allowable tensile stress, a.k.a., the tensile strength. The maximum allowable stress is substituted into the equation, and then the critical dimension is directly calculated.

Therefore, in summation, it would have been obvious to one of ordinary skill in the art at the time the invention was made:

1) to design the leading edge of the base ring of Hanzawa with a radius of curvature greater than or equal to a critical bending radius before the reinforcement fiber fails under tension in order to improve the load bearing capabilities of the reinforcement fiber as taught by Wright, and

2) to calculate a critical bending radius of the reinforcement fiber equal to the elastic modulus times the diameter, the product divided by twice the tensile strength (maximum tensile stress).

Claims 10, 12 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hanzawa, Wright and Higdon as applied to claims 1 and 6 above and in view of Nakajima (US 6,431,783).

Regarding claims 10 and 12, none of the previously cited references disclose a crimp ring with an edge curved inward such that the portion couples to the leading edge of the base ring.

Nakajima teaches a crimp ring (item 60 of Figs.5A and 5B) with a portion that is bent inward (item 63) in order to couple to the leading edge of the base ring. This improves the mechanical stability of holding the reinforcement fibers in place (col.6, lines 53-63).

It would have been obvious to one of ordinary skill in the art at the time the invention was made for Hanzawa to curve inward the edge of the crimp ring in order to couple it to the leading edge of the base ring such that additional crimping force is created as taught by Nakajima. This improves the ability of the connector to hold the reinforcement fibers in place.

Regarding claim 14, the prior art combination of Hanzawa, Wright and Higdon have the structure as stated above in the rejection of claim 1.

The prior art combination does not specifically disclose a crimp ring with an edge curved inward such that the portion couples to the leading edge of the base ring.

Nakajima teaches a crimp ring (item 60 of Figs.5A and 5B) with a portion that is bent inward (item 63) in order to couple to the leading edge of the base ring. This improves the mechanical stability of holding the reinforcement fibers in place (col.6, lines 53-63).

It would have been obvious to one of ordinary skill in the art at the time the invention was made for Hanzawa to curve inward the edge of the crimp ring in order to couple it to the leading edge of the base ring such that additional crimping force is created as taught by Nakajima. This improves the ability of the connector to hold the reinforcement fibers in place.

Claims 11 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hanzawa, Wright and Higdon as applied to claims 1 and 6 above and in view of Manning (US 5,781,681).

Regarding both claims, none of the previously cited references disclose a flexible sleeve being disposed over the crimp ring.

Manning teaches the use of a strain relief boot (Fig.1) made of a flexible material that has a sleeve portion (item 11) that is disposed over the crimp ring that crimps reinforcement fibers (item 26) over a base ring (see Figs.4-7). The flexible sleeve provides for connecting the strain relief boot to the connector, among other advantages. The use of the strain relief boot allows for protection of the optical fiber from being bent too far so that the optical signal does not attenuate.

It would have been obvious to one of ordinary skill in the art at the time the invention was made for Hanzawa to have a flexible sleeve disposed over the crimp ring in order to connect a strain relief boot such that the optical fiber is protected from optical or mechanical damage caused by tight bends as taught by Manning.

Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hanzawa, Wright, Higdon and Nakajima, as applied to claim 14 above, in view of Manning.

None of the previously cited references specifically disclose a flexible sleeve being disposed over the crimp ring.

Manning teaches the use of a strain relief boot (Fig.1) made of a flexible material that has a sleeve portion (item 11) that is disposed over the crimp ring that crimps reinforcement fibers (item 26) over a base ring (see Figs.4-7). The flexible sleeve provides for connecting the strain

relief boot to the connector, among other advantages. The use of the strain relief boot allows for protection of the optical fiber from being bent too far so that the optical signal does not attenuate.

It would have been obvious to one of ordinary skill in the art at the time the invention was made for Hanzawa to have a flexible sleeve disposed over the crimp ring in order to connect a strain relief boot such that the optical fiber is protected from optical or mechanical damage caused by tight bends as taught by Manning.

Response to Arguments

Applicant's arguments filed September 1st, 2004, have been fully considered but they are not persuasive. The applicants assert five points: 1) that tensile strength is different from tensile stress; 2) that the prior art reference Wright does not suggest that the radius of curvature of the leading edge is greater than or equal to the minimum bending radius of the reinforcement fiber; 3) that Wright does not suggest the mode of failure; 4) that Higdon does not suggest that the critical bending radius is a function of the tensile strength; and 5) that there is no motivation suggested in the prior art references, individually or as a whole, to make the asserted combination under 35 USC 103(a).

With respect to the first point, a clarification needs to be explained between "tensile stress" and "tensile strength." Mathematically, these terms are one and the same. To be specific and more precise, "stress" is a measure of a material's strength. "Stress" can be calculated and/or measured in order to describe the strength of the material. Specifically, tensile stress is a

force pulling on a cross section divided by the area of the cross section. "Strength" is a term often used in the art for referring to a maximum stress. For example, the "tensile strength" of a material refers to the maximum tensile stress that the material can withstand. Therefore, "tensile strength" and the "maximum tensile stress" are the same.

Regarding the second point, Wright specifically discloses diligence in determining an acceptable value of the radius of curvature of the leading edge (col.7, line 62, to col.8, line 7), even citing a specific value of the bend radius for the size and type of reinforcement fiber used, such that the strength of the reinforcement fiber is not compromised: "For...[the] fibers [used], the radius of the bend preferably *is at least about* 0.062 inch, this radius corresponding to a sharp drop off in strength *as the radius is decreased from this value*." The evidence of record is clear that, not only should the minimum bend radius of the reinforcement fiber be considered when designing the leading edge of the ring, but also direct determinations must be made in order to make sure that the radius of curvature of the leading edge is greater than or equal to the minimum bend radius of the fiber such that the reinforcement fibers do not fail. This makes the coupler as efficient and effective as possible.

Regarding the third point, since the discussion is about bending, the mode of failure is tensile. The failure mode of Wright is tensile failure. This is elementary to one skilled in the art. This is also shown by Higdon, as is further discussed below.

As pointed out in the above rejection and past rejections, Wright does not specifically disclose an empirical approach, where mathematical calculations are used directly to calculate the minimum bending radius of the reinforcement fibers. It is suggested from the line quoted above from Wright that an appropriate radius was experimentally determined, where the smallest possible radius before failure was determined by systematic trial and error.

This brings us to the fourth point. The textbook of Higdon, et al., specifically discloses the empirical mathematical relationship between the bending radius, elastic modulus and tensile stress of an object to be modeled. The radius of curvature is inversely proportional to the tensile stress σ that is caused by the bending moment M. To demonstrate the elementary determination claimed, see the following derivation below, and the subsequent solution of problem #7-5 on p.357, and then how it applies to the applicant's invention:

The skilled artisan recognizes that the board of problem 7-5 is simply an elongated object and is readily modeled by the stress-strain equations provided by Higdon. From equation 7-2, the skilled artisan takes the relationship:

$$1/\rho = M/EI$$

where ρ = radius of curvature, E = elastic (Young's) modulus, I = second moment of area (calculated from geometric properties of the cross sectional area), and M = the bending moment generated in the object being modeled.

From equation 7-1, the skilled artisan takes the relationship:

$$\sigma/E = Mc/EI$$

where σ = the normal (tensile) stress in the object being modeled, and c = the radius of the cross sectional area.

From here, the skilled artisan notices that the moment, M, is an unknown quantity that is hard to determine, whether experimentally or otherwise. E, I, ρ and σ can be either directly measured by experimentation or referenced from the data sheet supplied by the manufacturer of the object being modeled (given in the problem statement, in this case). The critical thickness t required by the problem statement is bound by the stress that cannot exceed 2000 psi (tensile strength). Therefore, the skilled artisan needs to solve both equations for M, the variable that the skilled artisan does not need:

Equ. 7-2: $M = EI/\rho$

Equ. 7-1: $M = I\sigma/c$

Now, the remaining expressions can be set equal to each other:

$$EI/\rho = I\sigma/c$$

Now, the skilled artisan solves for the radius c:

$$c = \sigma\rho/E$$

From the known geometrical relationship, the skilled artisan substitutes the thickness for the radius, where the thickness is twice as long as the radius: $t = 2c$, and we have the final equation:

$$t = 2\sigma\rho/E$$

and now, the known values can be substituted:

$$t = 2\sigma\rho/E = 2*2000\text{psi}*120\text{in}/800000\text{psi} = 0.60 \text{ in}$$ (see p.723 of Higdon).

From here, the skilled artisan has learned how to model an elongated object under bending and determined a critical dimension that was limited by the tensile strength of the material. Taking these teachings, and practicing the knowledge provided by Higdon by solving problem 7-5, the skilled artisan re-writes the above equation in terms of the bending radius and the diameter, which is the same as the thickness used in the above example ($t = d$):

$$\rho = Ed/2\sigma$$

and now, the skilled artisan takes the tensile strength from the data sheet supplied by the manufacturer of the reinforcement fiber and substitutes it for the tensile stress σ in the equation, and arrives at the minimum bending radius allowed by the reinforcement fiber. It is clear from the relationship that this is the minimum radius. If the radius were made any smaller, the skilled artisan can calculate that the stress would exceed the stress given on the data sheet of the reinforcement fiber.

Finally, regarding the fifth point raised by the applicant, motivation to combine the teachings of the prior art is clear at least from the teachings of Wright, in col.7, line 62, to col.8, line 7, specifically, "...this radius corresponding to a sharp drop off in strength as the radius is decreased below this value." First, it is clear that the bending radius of the reinforcement fibers is important to consider regarding the improved functionality of the connector. It is further clear that radii smaller than the dimension that Wright had determined would severely compromise the effectiveness of the reinforcement fibers that Wright used. The reinforcement fibers break significantly more easily when bent around radii smaller than that specified. Most importantly for the teaching of motivation, Wright took the effort to find that minimum bend radius because it provides for the most efficient connector. The connector can be made as small as possible without compromising the effectiveness of the reinforcement fibers. Radii any larger than that determined are unnecessary and make the connector bulkier. This motivation is also clear at least from Wright's abstract, which begins, "A fiber optic harness assembly having reduced weight and bulk..."

Furthermore, the motivation to combine the teachings of Higdon are learned from the example that Higdon provided in problem 7-5. First, Higdon is used simply to demonstrate that such empirical tools were known and available to one skilled in the art at the time the invention was made, as well as to show that the fundamental relationships claimed are well-established in the art. Second, and more to the point, Higdon teaches a problem solving ideology and methodology that engineers take with them in designing useful devices. Through the repetition of solving problems such as the example of 7-5 above, Higdon teaches the approach to a design problem from an empirical point of view. The situation must be modeled and calculated such that a design best suited to the purpose can be achieved readily and efficiently.

Wright teaches the same ideology. It is not clear which methodology Wright used - an empirical approach, an experimental approach, or both - but the teachings of Wright remain clear that the bend radius of the leading edge must be greater than or equal to the critical bend radius of the reinforcement fiber such that an optimal design is achieved, and Higdon provides the fundamental tools and teaches an empirical approach for one skilled in the art to specifically determine that radius.

Therefore, from the reason set out above, the prior art of record is clear that:

a) it is known from Wright to take into consideration that there is a minimum bending radius for a given reinforcement fiber that should not be smaller in order to prevent bending failure, that is, tensile failure, of the reinforcement fiber;

b) it is known from Wright to specifically determine an appropriate radius of curvature that is greater than or equal to the minimum radius of curvature of the reinforcement fiber, and to design the leading edges of the fiber optic cable assembly accordingly;

c) it is known from Higdon as a fundamental physical relationship that the radius of curvature is exactly a function of the tensile stress, elastic modulus and diameter of the object to be modeled; and

d) it is known from the suggestion of Higdon to calculate a parameter, such as the bending radius, when limited by another parameter, such as a tensile strength, by substituting the limiting parameter into the equation appropriate to the model of the object.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thomas R Artman whose telephone number is (571) 272-2485. The examiner can normally be reached on 9am - 6:30pm Monday - Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ed Glick can be reached on (571) 272-2490. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Thomas R. Artman
Patent Examiner

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SUPERVISORY PATENT EXAMINER